

# **Report for 2003GU24B: Improving Weno Water Distribution System Using Geographic Information System and Hydraulic Modeling Techniques**

There are no reported publications resulting from this project.

Report Follows

# **PROJECT SYNOPSIS REPORT**

## **Project Title:**

Improving Weno Water Distribution System Using Geographic Information System and Hydraulic Modeling Techniques.

## **Problem and Research Objectives**

Water hours and low delivery pressure have long been a part of the daily lives of the people in the Micronesia Islands. The problems with delivery of adequate supplies of water to the customers at appropriate pressure have become more and more of a challenge to Public Utilities through out these islands. Parts of these problems are due to phenomenal growth rate occurring in the island centers. This is particular true on the island of Weno in Chuuk State, Federated States of Micronesia (FSM).

Over the years the Chuuk Public Utility Commission's (CPUC) water distributions system has grown without adequate documentation as to the extent and size of supply and transmission resources and where these resources are located. Just recently several new wells were added to the CPUC's water supply. As built drawings of various portions of the system are non-existent and there is no comprehensive system map available that could be used as a base point for development of a hydraulic model of the system. The effective management of a utility requires up-to-date information on the physical resources available to the utility manger and how these resources work together to provide the customer with the utility mandated service. Modern and effective water utility management requires the use of Geographic Information Systems (GIS) and computerized hydraulic models of the distribution system to accomplish these management goals. Presently the expertise to use such up to date computer management techniques is unavailable at CPUC.

The objectives of this project were to:

1. Gather data on the complete physical and hydraulic description of the Weno water distribution system.
2. Develop a digital description of the system using the information developed in objective 1.
3. Develop a hydraulic model of the system using the information developed in objectives 1 and 2, and translate this model into a ArcGIS Database of system components.
4. Provide information on the quality of water being pumped from new Asian Development (ADB) funded wells and throughout the distribution system.

## **Methodology**

This proposed project was divided into four phases.

### **Phase I.** Gather complete physical and hydraulic description of the Weno water distribution system

The importance of this phase of the project cannot be overemphasized. It was impossible to develop either a GIS Utility management system or a system wide hydraulic network model until a complete physical description of the water system was available. This was a combined effort between CPUC's operation and engineering staffs and WERI researchers. For this phase all the information that describes the Weno water system such as system maps, as built drawings, and system operation was collected. Researchers used differential Global Positioning System (GPS) techniques to gather location information on system components not included on as-built drawings.

### **Phase II.** Development of GIS based Utility Management System

Upon the completion of the data-gathering phase WERI developed a series of digital maps describing CPUC's water system. The maps were developed in AutoCAD format. The maps and accompanying database files were presented to CPUC for verification by the engineering and operations divisions. Corrections were made to any inconsistencies found in the review. The database consisted of the following items:

1. Physical and location description of the pumps, pipes, valves and miscellaneous fittings in the system were gathered. Element attributes recorded include size, pipe length and diameter, materials, and connectivity to other components of the system. Such parameters as date of installation and condition of the component were added wherever available.
2. A complete physical and location description on all sources of water was gathered. For sources such as wells, all information about the components of the pumping and disinfections systems and their location with respect to the distribution system were added to the digital database.

### **Phase III.** Develop Hydraulic Network Model of the CPUC Water Transmission System

Phase III involved the development of a hydraulic network model of the CPUC system using Haestad Methods Cybernet model. This Windows based model is relatively easy to use and very sophisticated in its capability to model complex looped piping systems. Input data for the model were input from digital AutoCAD maps and the data bases developed in Phase II of the project using the Haestad WaterCAD model running inside the AutoCAD program. The AutoCAD data was then translated exported into ArcGIS shape file format along with the accompanying database files for the attributes of all of the hydraulic elements of the system.

#### **Phase IV. Water Quality Analysis**

As part of this study and at the request of Mr. Robert Hadley, Assistant Secretary of Infrastructure Federated States of Micronesia, National Government, samples of water were taken from the Chuuk Public Utility Corporation (CPUC) water distribution system on Weno Island. These samples were analyzed on site and at WERI's water quality analysis laboratory at the University of Guam.

#### **Principal Findings and Significance**

Phase I, II and III involved gathering data, providing a geometric description of the water system components in to AutoCAD drawing program, and providing the data required for the development of a hydraulic water distribution system model using the Haestad WaterCAD for AutoCAD program. Figure 1 and 2 shows the system map of the entire Weno water distribution system as represented in the model. Figure 3 provides a detailed close up description of the system located around the Chuuk State Hospital. Table 1 provides the data used to describe the water storage tanks in the system. Table 2 provides the data describing the wells and well pumps in the system. The water distribution system model is completely operational and ready for use by engineers and water managers seeking to optimize the water system operation.

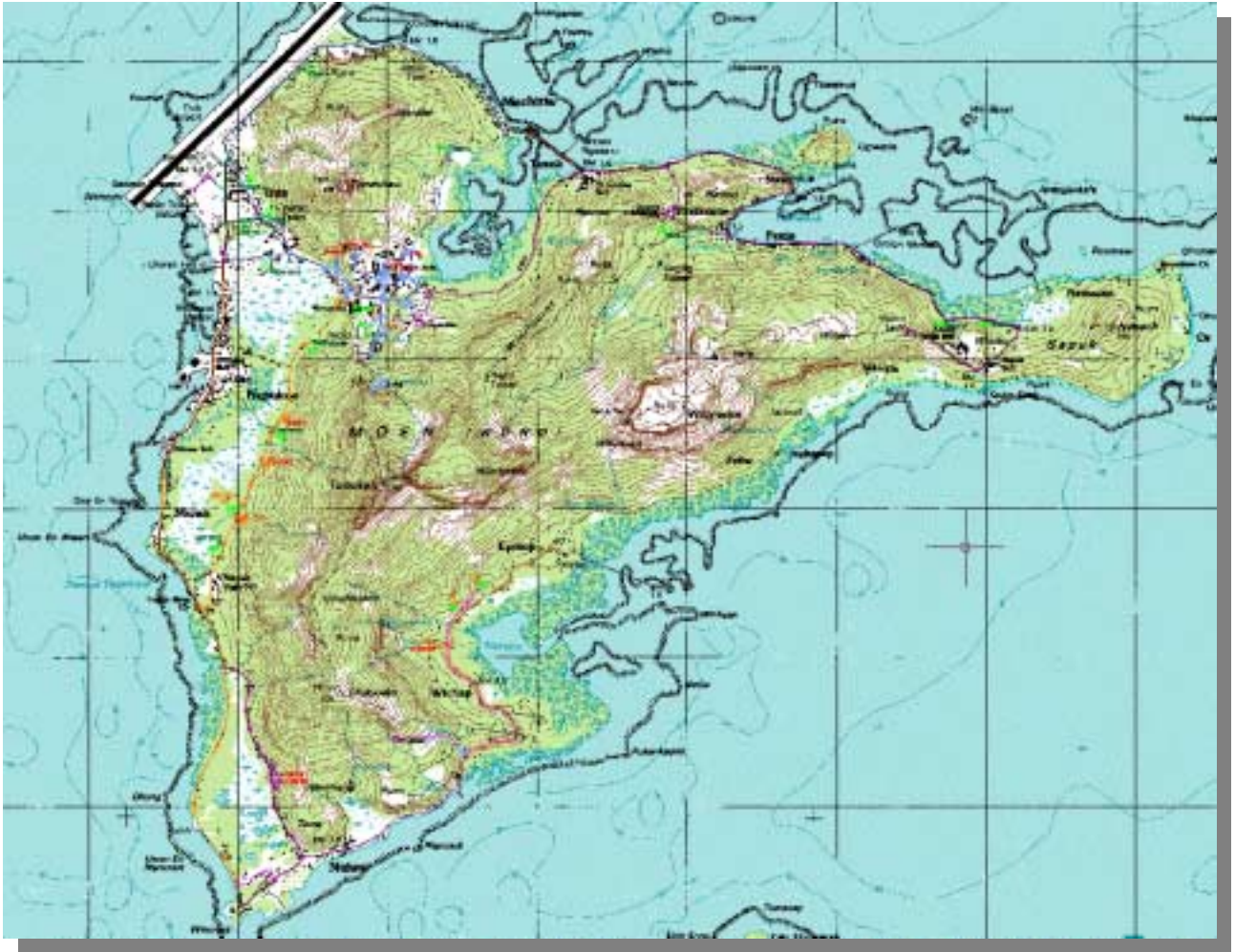
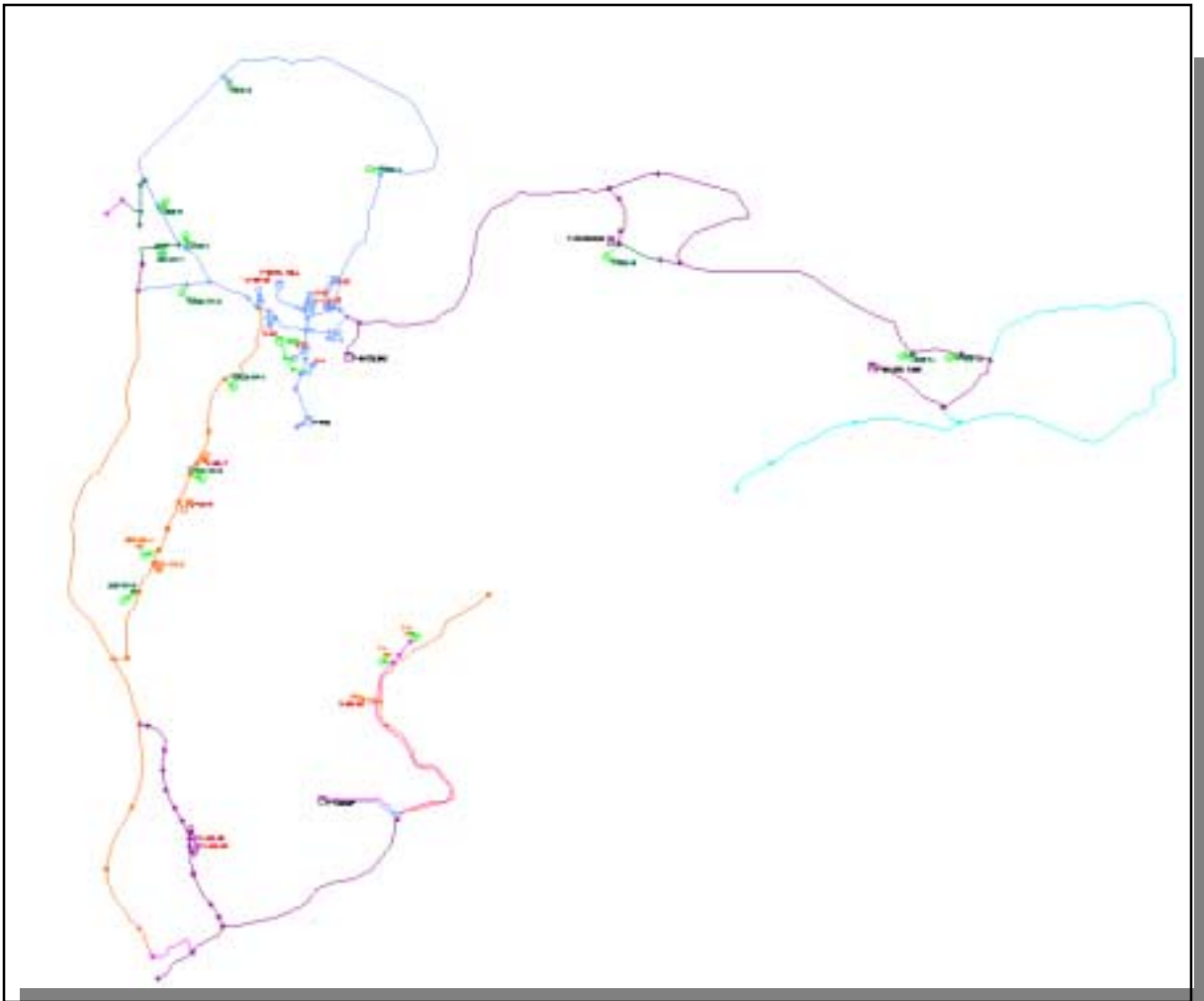


Figure 1 Weno, Chuuk Water Distribution System with USGS Topographic Map Background



**Figure 2 Weno, Chuuk Water Distribution System**

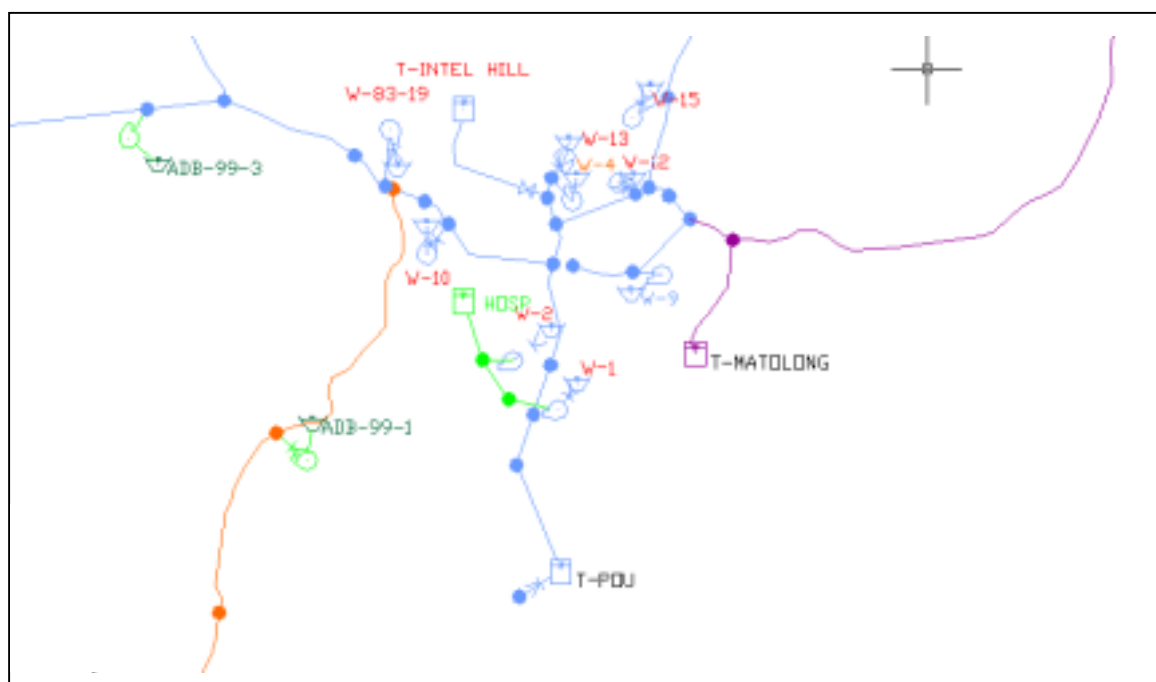


Figure 3 Details of Weno, Chuuk Water Distribution System near the Chuuk State Hospital

	Label	Total Volume (gal)	Tank Diameter (ft)	Base Elevation (ft)	Maximum Level (ft)	Minimum Elevation (ft)	Maximum Elevation (ft)
T-XAVIER TANK	T-XAVIER TANK	999,915.98	75.32	217.00	30.00	217.00	247.00
T-POU	T-POU	999,945.62	65.23	219.00	40.00	219.00	259.00
T-WICHAP	T-WICHAP	999,963.25	72.93	157.00	32.00	157.00	189.00
T-INTEL HILL	T-INTEL HILL	999,892.79	70.75	156.00	34.00	156.00	190.00
T-MATOLONG	T-MATOLONG	1,999,961.09	100.06	156.00	34.00	156.00	190.00
T-PENIESENE	T-PENIESENE	1,000,079.98	77.97	158.00	28.00	158.00	186.00
HOSP	HOSP	0.00	10.00	0.00	0.00	0.00	0.00

Table 1 Description of Tanks in the Weno, Chuuk Water Distribution System

Label	Pump Definition	Elevation (ft)	Label	Pump Definition	Elevation (ft)
PMP-83-22	60S30-5	0.00	PMP-14	60S75-13	0.00
PMP-83-30	60S30-5	0.00	PMP-16	60S20-4	0.00
PMP-TH-5	60S30-5	0.00	PMP-17	60S75-13	0.00
PMP-TH-9	60S50-9	0.00	PMP-18	60S50-9	0.00
PMP-83-7	60S30-5	0.00	PMP-20	60S50-9	0.00
PMP-10	60S30-5	0.00	PMP-21	60S75-13	0.00
PMP-83-19	60S50-9	0.00	PMP-22	60S50-9	0.00
PMP-15	60S30-5	0.00	PMP-23	60S75-13	0.00
PMP-2	60S50-9	0.00	PMP-24	60S75-13	0.00
PMP-1	60S50-9	0.00	PMP-25	60S50-9	0.00
PMP-12	60S50-9	0.00	PMP-26	60S50-9	0.00
PMP-13	60S30-5	0.00	PMP-27	60S20-4	0.00
PMP-7	60S30-5	0.00	PMP-28	60S30-5	0.00
PMP-83-25	60S30-5	0.00	PMP-29	Default Pump De	0.00
PMP-19	60S30-5	0.00	PMP-30	Default Pump De	0.00

Table 2 Well Pump Descriptions

As part of this study, samples of water were taken from the Chuuk Public Utility Corporation (CPUC) water distribution system on Weno Island. Water samples were taken from the newly constructed Asian Development Bank (ADB) funded wells, the older existing wells, from points in the distribution system, and at the Pou water treatment facility. Sampling points are shown in Figure 4.

Physical parameters such as pH, Conductivity, Residual Chlorine and Turbidity were measured at the time the samples were taken, bottles of water were also collected for bacterial and additional chemical analysis. The samples were analyzed for total coliform and *E. coli*. Water samples were taken back to the WERI facility for testing for Nox, PO4-P, Chloride, Calcium, Magnesium, Total Hardness, Iron, Manganese, and Sulfate. A complete listing of all of the analysis results is available in a WERI special report titled “Water Quality Testing Chuuk Public Utility Corporation, Chuuk State, Federated States Of Micronesia (FSM)” by Dr. Leroy F. Heitz and Mr. Harold Wood.

In general the chemical quality of water coming from the wells and the surface water treatment plant is good. Of concern are the chloride levels in Wells ADB 99-3 and ADB 99-4. Both of these sites also had relatively high conductivities. It would be good if the well withdrawal rates were reduced until the chloride levels and conductivities were more in line with the other wells in the system.

The most serious problems are bacterial in nature. Virtually all of the source waters had indicator bacteria total coliform counts greater than zero and many of the sites tested positive for *E. coli*.

Few of the ADB-Well chlorination systems were operating and none of the existing wells (pre-ADB wells) have chlorination systems at all. This means that only a small number of distribution system customers are being delivered safe potable water. It is

recommended that all wells be provided with chlorinators and that adequate supplies of chlorination chemicals be maintained to keep all of these chlorinators operating on a 24 hour 7 day a week basis. Until the entire system is chlorinated the public should be notified that the water must be treated by boiling, home chlorination or some other means in order to make it safe for consumption.

The CPUC should purchase an inexpensive electronic chlorine residual meter and tests should be made on at least a weekly basis both at the well sites and in the distribution system to be sure that adequate Chlorine residuals are being maintained through out the distribution system. After the entire system is chlorinated, additional studies should be made to determine if the water is receiving adequate chlorine contact time before being delivered to customers.



Figure 4. Water Sampling Sites in the Weno, Chuuk Water Distribution system